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UNITED STATES
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BUREAU OF MINES
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INFORMATION CIRCULAR

MARKETING SILICA (QUARTZ, TRIPOLI, DIATOMITE, ETC.)

BY

NAN C. JENSEN

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MARKETING SILICA (QUARTZ, TRIPOLI, DIATOMITE, ETC.)[1/]

By Nan C. Jensen[2/]

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INTRODUCTION

Silica, the world's most abundant mineral compound, is composed of the two commonest elements - oxygen and silicon. In addition to being the life-giving constituent of the atmosphere and the major element in the waters of the earth, oxygen comprises almost half of all known terrestrial matter and occurs combined with most of the other ninety-odd elements in the solid crust of the earth; however, a large proportion of the oxygen is combined with silicon. Silicon is second only to oxygen in abundance in nature and constitutes more than one-fourth of all known terrestrial matter. The compound of oxygen and silicon, called silicon dioxide or silica, forms 59.08 percent of the earth's outer 10-mile crust. Some of the silicon dioxide exists as

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free silica, but much of it is united with oxides of various metals to form feldspars, micas, and other important silicate minerals. Combined with other elements in the form of silicates, silica loses its mineralogical identity but appears in the chemical analyses of many industrial minerals and ores, as well as commercially worthless rocks and clays. Sometimes the silica is present as an impurity.

Various Forms of Silica

Silica occurs as quartz, tridymite, cristobalite, chalcedony, opal or diatomite. Quartz alone comprises fully 12 percent of the earth's crust. The term "quartz," as generally used, includes virtually all sands, sandstones, and quartzite, as well as vein and crystal quartz. The chalcedonic group includes such useful minerals as agate, flint, and tripoli, as well as many gem stones.

Occurrence

Massive vein quartz occurs filling cracks and cavities of rocks; quartz crystal in six-sided prismatic crystals in veins or cavities and sometimes loose in top soil or in old river beds; chalcedony in stalactitic or concretionary form or as a lining of cavities; flint in nodules in limestone or chalk beds; opal in stalactitic or concretionary form or as masses in veins and cavities; sandstone and quartzite in rock formations; sand in unconsolidated grains; and tripoli and diatomite in deposits of soft material. Tridymite and cristobalite occur in minute crystals or crystalline aggregates in many siliceous volcanic rocks and are formed when quartz is heated to high temperatures under certain conditions.

Silicified or petrified minerals, shells, and wood contain silica as a replacement of the original material. Silica is also a very important rock-forming mineral. It occurs in the form of quartz as a constituent of granite and similar rocks and in gneisses and schists.

Properties

Except for opal and diatomite, which contain a small and variable quantity of water in their molecular make-up, all forms of silica have the same chemical composition. They are composed of silicon dioxide, which has the chemical formula SiO_2 and contains, when pure, 46.7 percent silicon and 53.3 percent oxygen. Impurities, generally small inclusions of oxides of various metals, often are present and may affect the color. Vein quartz is typically milky white and pure quartz crystal water-clear and colorless, but owing to impurities quartz, like other forms of silica,

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has many color variations. The various forms of silica have certain general characteristics. They are hard, able to withstand comparatively high temperatures, virtually unaffected by exposure, infusible, acted on only slightly by any acid except hydrofluoric, and insoluble in water; however, they are brittle and, when broken, differ in their fractures. Quartz (vein and crystal), flint, and opal break with a shell-like fracture. Chalcedony has a somewhat splintery fracture. Quartzite breaks with either a shell-like or splintery fracture straight through its cement and grains alike, whereas sandstone breaks through the cement and around the grains, leaving a broken surface that appears rough or granular. The various forms also differ in luster - quartz has a glassy luster, some vein quartz a greasy luster, chalcedony a waxy luster, and the soft silicas an earthy luster, whereas opals may have a glassy, dull, or greasy luster. In addition, each form of silica has some unique properties.

Uses

Certain varieties of silica, such as amethyst, cairngorm, and rose quartz, have been prized as ornamental stones, and other varieties have been in everyday use since the earliest times. Flint was perhaps the most essential mineral in the primitive Stone Age. For thousands of years flint was used to strike fire. The safety matches of today also contain silica in the form of pulverized quartz, sand, or glass, and sometimes the match top or the striking strip on the box contains diatomite. The ancients fashioned flint into implements of warfare, such as axheads and arrowheads. In modern times other types of fighting tools are used, but quartz crystal is employed in radio and telephone apparatus, range finders, and other military equipment. The present uses for silica in its many forms are numerous and varied; they range from the use of huge, compact blocks of sandstone for building stones to the use of the soft, earthy diatomite as a filter aid.

Pulverized silica is employed as abrasives and fillers. Finely pulverized products made from such hard materials as quartz, quartzite, sandstone, quartz sand, or flint are employed in harsher scouring and buffing compounds, soaps, and metal polishes where strong abrasive action is desired and as fillers in wood pastes where sharpness or angularity of grains is necessary. The powdered, soft silicas such as tripoli are used as mild abrasives and as fillers in paints and in ready-mixed fillers and filler stains. They are termed "soft silicas" to distinguish them from pulverized quartz or flint.

Lump or crushed quartz and quartzite, silica brick made from "ganister" or quartzite, sandstone blocks, siliceous "mica schist," common sand, and diatomite are some of the refractory materials used in furnaces. Furnace linings and other products classed as refractories must be able to

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withstand high temperatures, chemical action, and physical wear - properties that silica possesses.

The chemical composition of silica is important in many of its uses. Glass sand, potters' flint, and other classes of ground quartz or sand employed in the ceramic industries are valued for their high silica content and freedom from iron, titanium, or other impurities that would color the product. Chemical purity is also important in quartz used in making fused quartz, and physical structure may be important, particularly if optical properties or a product of especially good appearance is desired. Moreover, purity is important in quartz used for lining acid towers or making sodium silicate (water glass) and silicon carbide, as well as in molding sand, especially steel-molding sand. The chemical purity of silica is somewhat less important in many other uses, even where the product is to be melted, as in fluxing quartz for metallurgical operations or raw material for making ferrosilicon; however, undue proportions of other substances might unfit even sand for general industrial uses that merely demand a reasonably clean, hard, tough material.

In general, however, the classification of uses by chemical composition is not as important as by size, and an attempt to summarize the numerous uses for silica according to sizes follows.

Dimension stone (blocks or slabs). - Rough block, cut stone, rubble, paving blocks, and flagging; furnace block (much so-called "mica schist," used for refractory furnace linings, falls in this category); silex or quartzite tube-mill lining blocks and grinding "pebbles" or cubes; grindstones, pulpstones, whetstones, scythestones, etc.

Broken or crushed stone. - Acid-tower lumps (2 to 8 inches), ferrosilicon manufacture (1 to 3 inches), concrete aggregate, fluxing quartz or stone (or siliceous ores), ganister, riprap, rough agate.

Pebbles. - Natural flint grinding pebbles (1 to 6 inches) for tube mills.

Chips and granules. - Bitstone or coarse placing sand for potters, roofing granules, stucco, and terrazzo; building, paving, and railroad gravel.

Sand. - Sand-blasting, glass-grinding, and miscellaneous abrasives; wire-saw and stone-cutting sand; ganister (silica brick); fire or furnace (refractory) sand; glass sand (similar grades used for making sodium silicate and silicon carbide); paving, roofing, asphaltic, bed, concrete, brick-mortar, plastering, molding, core, filter, engine, and lime-brick sand.

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Powder. - Plaster and cement filler, asphalt filler, paint and wood filler, potters' flint, rubber filler, and miscellaneous filler; silica wash for steel-foundry molds; parting sand; cleaning, polishing, and scouring compounds.

In spite of these many uses, experiments are still being conducted to find new ways to employ the properties possessed by the various forms of silica. For many years, scientists knew of the so-called piezoelectric properties of quartz, namely, that electrical charges could be generated in fragments of crystals by pressure and that slices of quartz crystal could sort out electrical impulses of different frequencies in much the same way as a tuning fork sorts out sound vibrations of a certain pitch. Nevertheless, the wide use of quartz crystals in radio apparatus is relatively recent, and not until 1937 were they employed extensively in telephony. The significance of quartz in modern communications is indicated by its universal use in wireless apparatus and the fact that as many as 720 simultaneous telephone conversations can be carried by a single wire when each circuit is controlled by a pair of quartz plates. This necessitates 720 plates of different size at each end to initiate and receive the messages.

Production

Deposits of massive quartz, quartzite, sandstone, and sand and gravel are extensive and widely distributed, but no substantial deposits of quartz crystal suitable for use in optical and radio equipment have been discovered in the United States. Several hundred pounds of quartz crystal have been mined in a year in Arkansas for radio and optical use, and occasionally crystals suitable for optical use have been found in other States, but Brazil remains virtually the only source of high-grade crystals. In 1940 imports of Brazilian quartz crystal into the United States totaled 126,521 pounds valued at $264,436. Quartz crystal of lower grade is abundant in the United States, and many hundreds of tons a year are even thrown away as waste at feldspar quarries.

Production of gems and ornamental stones for sale to jewelers, tourists, collectors, and rock gardeners (estimated in 1940 at $750,000) has been reported from many States, but these stones are produced largely by individuals or partnerships and there are no official returns. The 1940 output of gem stones for use in jewelry has been roughly valued at $340,000, of which about 87 percent belonged to the agate family. Agates of considerable beauty, if not of great size, are found in many localities in the United States. Those found in Michigan on the shores of Agate Bay, Lake Superior, have rich natural coloring and make attractive charms and ornaments. Agates occur in the stream beds of many rivers in Montana, Colorado, and other regions of the Rocky Mountains. They are found also along the

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Mississippi River (especially in Minnesota) along the Fox River in Illinois, in the trap rocks bordering the Connecticut River, and on the coasts of California and Oregon. Considerable unmanufactured agate is imported into the United States from Uruguay and Brazil.

No true flint is mined in the United States either for grinding pebbles or ground flint. Flint grinding pebbles have come chiefly from Denmark and France and silex liners from Belgium, but imports of flint in 1940 dropped to 2,840 short tons valued at $32,397 from 11,987 tons valued at $116,019 in 1939. The decrease is being offset by increased production of artificial pebbles in the United States and by use of various substitutes. Formerly much flint was imported in the form of pebbles imbedded in crude chalk, the pebbles being removed before the chalk was ground into whiting, but the importation of foreign chalk for grinding into whiting has dwindled to small proportions. Much of the material sold to the pottery trade as "ground flint" is ground quartz or sand, although considerable true flint is ground in the United States for ceramic purposes. Chert or hornstone, which resembles flint but is more brittle and splintery and less pure, occurs in the North Central States.

Novaculite, an unusual chertlike quartzose rock, is quarried principally in the vicinity of Hot Springs, Ark. Tripoli was mined in 1940 in Arkansas, California, Illinois, Missouri, Oklahoma, and Texas; rottenstone in Pennsylvania. Both salt-water and fresh-water diatomite are fairly plentiful throughout the world, but relatively few deposits comprise material pure enough or of the type that can be used in the process industries. The most important commercial deposit is near Lompoc, Calif. True buhrstone is not produced in the United States, and domestic millstones are made from any hard and suitable rock, such as sandstone, granite, quartzite, or quartz conglomerate.

The following table presents data on domestic production in 1940 of silica in its various forms.

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Silica products sold or used by producers in the United States, 1940

Commodity	Number of States reporting production	Short tons	Value	
			Total	Average per ton
Quartz from pegmatite dikes and veins, and quartzite:				
Crude		3,606	$17,099	$4.74
Crushed		17,652	58,897	3.34
Ground		10,607	100,394	9.46
Total	13	31,865	176,390	5.54
Quartz crystal	(1/)	(1/)	(1/)	
Gem and ornamental stones (quartz, chalcedony, and opal)	(1/)	(1/)	(1/)	
Quartzite	(2/)	(2/)	(2/)	
Sandstone (by uses):				
Dimension stone:				
Building	23	100,310	759,540	7.55
Paving blocks	1	510	3,740	7.33
Curbing	3	24,500	344,355	14.06
Flagging	14	46,510	318,569	6.85
Total dimension stone	23	172,130	1,426,204	8.29
Crushed and broken stone:				
Refractory stone (ganister)	15	852,470	1,536,450	1.80
Riprap	21	340,960	284,845	.84
Concrete and road metal	28	3,337,030	3,583,325	1.07
Railroad ballast	3	199,260	178,468	.90
Other uses	8	1,597,110	1,504,362	.94
Total crushed and broken stone	32	6,326,830	7,087,450	1.12
Grand total - sandstone	33	6,498,960	8,513,654	1.31
Ground sand and sandstone (by uses):				
Abrasive:				
Cleansing and scouring compounds		77,734	396,594	5.10
Other		10,718	53,677	5.01
Enamel		22,978	141,334	6.15
Filler		6,109	68,004	11.13
Foundry		58,306	324,659	5.57
Glass		9,883	51,327	5.19
Pottery, porcelain, and tile		137,228	942,996	6.87
Other uses		19,262	109,723	5.70
Total ground sand and sandstone	11	342,218	2,088,314	6.10

See footnotes at end of table.

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Silica products sold or used by producers in the United States, 1940 (Cont'd.)

Commodity	Number of States reporting production	Short tons	Value	
			Total	Average per ton
Sand and gravel (by uses):				
Sand:				
Building	3/48	34,740,644	17,282,151	.50
Paving	4/48	30,407,866	13,697,249	.45
Molding	29	5,004,807	5,268,974	1.05
Glass	18	2,759,544	4,881,508	1.77
Engine	42	1,634,968	1,069,630	.65
Grinding and polishing	31	856,309	915,925	1.07
Fire or furnace	16	270,715	325,713	1.20
Filter	21	118,600	164,061	1.38
Railroad ballast	27	957,745	256,439	.27
Other sands	44	1,923,042	1,469,979	.76
Total sand	3/48	78,674,240	45,331,629	.58
Gravel:				
Building	3/48	33,295,541	20,127,100	.60
Paving	5/47	112,750,100	40,569,012	.36
Railroad ballast	38	10,880,779	3,627,796	.33
Other gravels	38	2,707,607	1,032,597	.38
Total gravel	6/48	159,634,027	65,356,505	.41
Grand total - sand and gravel	6/48	238,308,267	110,688,134	.46
Flint and flint stones, unground	-	-	-	
Chert or hornstone	(1/)	(1/)	(1/)	
Novaculite	1	(7/)	(7/)	
Tripoli and rottenstone	7	30,212	366,569	12.13
Diatomite	8	(8/)	(8/)	
Millstones and chaser stones	3	(1/)	6,558	
Grindstones	2	8,790	284,809	32.40
Pulpstones	2	4,533	211,639	46.69
Oilstones, whetstones, hones, scythe stones, and rubbing stones	4	(9/)	(9/)	

1/ No official data available. 2/ Sales of quartzite reported with either vein quartz or sandstone, according to use. 3/ Also Hawaii and Puerto Rico. 4/ Also Puerto Rico. 5/ Also Alaska and Puerto Rico. 6/ Also Alaska, Hawaii, and Puerto Rico. 7/ Reported under oilstones and whetstones. 8/ Bureau of Mines not at liberty to publish annual production figures on diatomite. Total output for 3-year periods may be shown, and sales during the period 1936-38 totaled 279,645 short tons valued at $4,377,353. 9/ Bureau of Mines not at liberty to publish 1940 data on oilstones, etc., but in 1939 production was 620 short tons valued at $115,805

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Prices

Silica has the widest price range of any known mineral because of its numerous forms and diversified uses. The value of a particular silica depends not only upon its composition but also upon its form and potential uses. Each variety has individual characteristics that fit it for certain uses. The following pages contain brief discussions of the properties, uses, and prices of the many varieties.

MASSIVE VEIN QUARTZ

Massive vein quartz - a crystalline silica that occurs in broad bands filling pegmatite dikes and veins - may be recognized by its glassy, sometimes greasy, luster and hardness. Quartz cannot be scratched with a knife, and on Mohs' scale of hardness it has been placed at 7, between feldspar (6) and topaz (8). It has a specific gravity of 2.65, indicating that it is slightly more than 2-1/2 times as heavy as water. Usually vein quartz is milky white or colorless, but it also occurs in many colors and is transparent to opaque.

Vein quartz of high purity, after grinding to sand sizes, is used in the manufacture of whiteware, enamelware, and fused silica, also as a source of silicon in the manufacture of sodium silicate and silicon carbide. A small quantity of vein quartz in comparatively large pieces is employed as packing material in acid towers, as flux in smelting, and as a source of silicon in the manufacture of ferrosilicon. Some lump and crushed quartz is used for refractory purposes. Pulverized quartz is used in scouring and buffing compounds, soaps, and metal polishes where stronger abrasive action is desired than is obtainable with tripoli or diatomite. It is employed as an abrasive for sandpaper and as fillers in wood pastes and other products, and a small quantity is used in rubber erasers. Massive rose-colored quartz has value as a gem and ornamental stone.

Vein quartz is sometimes called rock quartz and in the ceramic industry is commonly but improperly termed "flint." Although potters and some other consumers use the term "flint" loosely to cover all forms of silica, mineralogists generally reserve the term to describe one of the chalcedonic varieties of silica.

Rock quartz may be priced as low as 50 cents to $1 a ton, and crushed or pulverized quartz ranges in price from $5 to $40 a ton, the top price being for a high-quality, water-ground and floated grade. Much vein quartz used for making fused silica ware and in metallurgical and chemical plants sells for $1 to $2.50 a ton. Selected vein quartz suitable for grinding and use in the manufacture of whiteware and enamel is worth up to $10 a ton, delivered at New York or New Jersey mills.

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QUARTZ CRYSTALS

Quartz crystals are hexagonal prisms terminated by pyramids and ranging in size from huge crystals weighing hundreds of pounds to tiny crystals in finely crystalline coatings. Owing to lack of space in which to grow properly, crystals are often bent, twisted, or greatly distorted. Quartz crystals are found in veins in clay or more or less bedded rocks, loose in top soil or old river beds containing the debris from eroded veins, attached to the walls of cavities, and often lying loose in the cavities. Virtually all the prism faces are more or less deeply striated or grooved horizontally, and usually the pyramid faces are smooth. Pure quartz crystal is colorless, but impurities add color. Quartz crystal has piezoelectric properties; however, flaws in its structure may affect this property of quartz even more than its optical properties.

Quartz crystal when flawless, transparent, and possessing the necessary piezoelectric properties has great strategic importance. In thin plates it is employed in radio apparatus and telephony for frequency control. Other uses of high-grade quartz that are of strategic interest are in range finders, in instruments for measuring pressures or detonation in gun barrels or airplane engines, in depth-sounding and direction-finding apparatus, and for sundry precision instruments such as chronometers, seismographs, periscopes, gun sights, and polariscopes. Quartz crystals are cut and ground for lenses, prisms, and wedges employed in photographic, optical, spectrographic, and many other specialized instruments; for these uses the crystals need not have the piezoelectric properties necessary for radio quartz but should have the same degree of purity. Slightly inferior crystals unsuitable for grinding may be used for the manufacture of fused quartz. Inferior crystals are pulverized and employed for cutting and polishing in the glass and porcelain industries. Attractive specimens of quartz crystal find use as gem and ornamental stones.

Some large users prefer quartz crystals weighing 3 to 8 pounds and having at least two crystal faces for cutting into commercial piezoelectrical plates, but small shops use crystals weighing only one-half pound or less, provided they are reasonably free from twinning, cracks, bubbles, and other flaws. Many imperfections other than twinning, which is one of the commonest and most serious defects, can be seen with the naked eye. Twinning and piezoelectric properties frequently can be determined only by laboratory methods. Colorless crystals are preferred, but citrine and smoky quartz have been employed by some manufacturers. The high-grade crystals sell for $2 to $20 or more a pound, which is several times as much as ordinary quartz crystals are worth a ton. Water-clear crystals used as raw material for the better grades of fused quartz are quoted nominally at $100 to $150 a ton regardless of size.

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GEM AND ORNAMENTAL STONES

Gem quartz occurs both as colorless and exquisitely colored crystals or crystalline masses, which usually are transparent; it is much in demand. The gem varieties of quartz include the following:

Amethyst - light to dark purple, easily decolorized by heat, often in crystals.

Aventurine (quartz including brilliant flakes of mica or hematite) - yellow, brown, green, or red.

Cairngorm stone or smoky quartz - smoky gray, smoky yellow, or smoky brown, easily decolorized by heat, frequently in crystals.

Cat's-eye (quartz having a fibrous structure or containing fibers of asbestos) - gray, brown, or green.

Citrine - light yellow, often improperly sold as some form of "topaz."

Milky quartz - milky white, sometimes with greasy luster, translucent to opaque, rarely found in crystals; variety containing native gold called "gold quartz."

Rock crystal - colorless and water clear, commonly in distinct crystals, often sold as rhinestone and improperly as some form of "diamond," such as Herkimer diamond, Lake George diamond, Mexican diamond, Alaska diamond, or Cornish diamond.

Rose quartz - rose red or pink, becoming paler on exposure to light, transparent to translucent, usually massive.

Rutilated quartz (rock crystal containing needlelike crystals of rutile) - rich red when viewed by direct light.

Sagenitic quartz (rock crystal containing needlelike crystals of rutile, tourmaline, or other minerals that had crystallized before the quartz) - known also as Venus or Thetis hairstone but usually named from the included mineral, as rutilated quartz or tourmalinated quartz.

Sapphire quartz - indigo or Berlin blue, rare.

Chalcedony, a variety of silica also found in pleasing colors, may occur in stalactitic or concretionary form or as a lining of cavities; it is transparent to translucent. Chalcedony has the same hardness as quartz but is more compact in structure and has a waxy luster. It is white, gray,

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brown, blue, yellow, or black, but small inclusions of oxides of various metals add other colors, resulting in many types, some of which are translucent to opaque. The chalcedonic minerals include the following:

Agate - composed of differently colored or clouded layers or bands that usually follow the shape of the cavity in which the agate was formed. The difference in formation and color of the bands is the basis for naming the many varieties of agates, such as banded agate, eye agate, fortification agate, and mocha, moss, or scenic agate. In the last-named variety the impurity, often manganese oxide, occurs in mosslike patterns.

Carnelian and sard - deep blood red to pale red and brown; the more reddish variety is termed "carnelian" and the yellowish and brownish, "sard."

Chrysoprase - apple green.

Flint - gray, smoky, brown, or black; translucent to opaque.

Heliotrope or bloodstone - dark green, with red spots and streaks.

Jasper - red, yellow, brown, dark green, or grayish blue; opaque and rather impure.

Onyx - generally black and white in alternate bands, the bands or layers being in parallel straight lines.

Plasma - green, often dark grass green, with irregularly distributed white or yellowish spots; translucent to opaque.

Prase - dull leek or sage green.

Sardonyx - combination of layers of carnelian or sard and white layers of chalcedony.

Opal, another form of silica, usually occurs in compact and irregular masses in veins and cavities but sometimes is earthy, stalactitic, or concretionary in form. Opal is not as heavy or hard as quartz and chalcedony and is easily broken. Like quartz and chalcedony, opal occurs in different colors. Often a beautiful play of colors may be observed in a single specimen.

The principal varieties of opal follow:

Precious opals - opals with a pleasing combination of colors or an attractive opalescence. They may be yellow, white, dark gray, blue, or red; those lighter in color are called white opals and the dark gray and blue opals, black opals. Fire opals are orange yellow to red.

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Common opals - opals having a waxy luster and little or no color. Those colored milky white, yellowish, bluish, or greenish are called milk opals. Those colored wax, honey, or other yellow are called resin opals. Hyalite opals are colorless, resembling drops of molten glass.

Geyserite or siliceous sinter - a soft, opaque opal deposited by hot springs and geysers; white, gray, or brown, sometimes with a pearly luster.

In petrified or silicified minerals, shells, and trees, the original material has been replaced by silica. These minerals also may be used for gem or ornamental purposes. Silicified crocidolite, whose asbestos silk like fibers have been impregnated with quartz, occurs in two varieties. The yellow-brown variety is called Tiger's eye and the grayish blue, Hawk's eye. Wood that has been silicified may be called agatized, opalized, or petrified.

The various gem and ornamental stones are cut into beads and gems for rings, pins, and other articles of jewelry, also into cups, vases, bottles, dishes, crystal balls, paper weights, umbrella handles, and ornaments. Agate, onyx, and sardonyx are utilized for making cameos, the bands of the minerals being utilized by carving the figures in one band and leaving the next band of another color as the background. Cheaper grades of rose quartz are used in monumental work; facings for fireplaces; tops of water fountains; and in pebble dash, a stucco finish in which crushed rock is embedded in the stucco base. The value of gem and ornamental stones depends mainly upon attractive color and freedom from defects that affect their appearance or hardness.

Agate

Agate is used not only as a semiprecious stone in jewelry and as an ornamental material but also in making mechanical bearings and supports, bearings of scientific instruments, scale bearings in analytical balances, balls for water meters, and small laboratory mortars, pestles, and spatulas. Most agate employed for commercial purposes is colored by artificial means, commonly by impregnating with honey and then boiling with sulfuric acid. Agate pebbles collected on the shores of Lake Superior have been used as a grinding medium in pebble mills. Playing marbles have been cut from agate, but the work of cutting the agates into spheres makes them expensive; most so-called "agate marbles" are made of glass, striped and colored to resemble agate.

QUARTZITE

Quartzite, composed of grains of sand cemented together by secondary quartz, is a sandstone changed by geologic processes (pressure and heat)

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into a more compact and harder rock. It has the appearance of massive quartz. Typical quartzite is white, but impurities add colors, such as red, pink, gray, or brown.

Small-lump or crushed quartzite and quartz are used for linings of some furnaces; however, silica brick is the principal acid refractory product employed by metallurgists, and such brick usually is made from crushed and suitably sized quartzite bonded with a small quantity of lime. The quartzite ordinarily used in making silica brick is known as ganister and contains about 98 percent silica. Comparatively large pieces of quartzite are employed as a flux in smelting, packing material in acid towers in the chemical industry, and as a source of silicon in the manufacture of ferrosilicon. Ground quartzite of high purity is utilized as a source of silicon in the manufacture of silicon carbide or sodium silicate. Pulverized quartzite is the raw material for some of the silica abrasives. Large pieces of quartzite are made into millstones and chaser stones for grinding minerals. Artificially rounded grinding pebbles and tube-mill liners also are produced from quartzite.

Crude quartzite may be priced as low as 50 cents to $1 a ton, but much of the quartzite used in metallurgical and chemical plants sells for $1 to $2.50 a ton.

SANDSTONE

Sandstone is a rock composed of grains of sand bound together by deposited quartz, calcite, iron oxide, or clay. The color of the resulting sandstone depends chiefly on the color of the cement, which may be white, gray, red, or yellow.

Sandstone is sawed, cut, or split to different dimensions for use as building stone, paving block, curbing, and flagging. Crushed and broken sandstone is employed as refractory material. Waste sandstone in large irregular blocks is used as riprap for shore protection, for spillways at dams, and for the construction of harbor breakwaters; moreover, it may be crushed for use as roadstone, concrete aggregate, and railroad ballast. Crushed sandstone also is employed in the manufacture of spun glass, poultry grit, rock dust, rock wool, roofing granules, and other products. Certain sandstones having a high silica content yet easily reduced to original grains by crushing are used as a source of some of the better grades of sand. Large pieces of sandstone are employed in making grindstones, pulpstones, whetstones, hones, scythestones, rubbing stones, millstones, and chaser stones; however, in making millstones and chaser stones any hard, suitable rock may be used, such as granite, quartz conglomerate, quartzite, or sandstone. Some whetstones are made from novaculite.

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The value of a sandstone is largely fixed by its silica content, strength and character of the cementing medium, size of the individual sand grains, and (for building purposes) color and resistance to weathering. The average prices paid for sandstone in 1940, by uses, are given in the table on page 7.

GROUND SAND AND SANDSTONE

Ground sand and sandstone are used as a source of silica in the manufacture of pottery, porcelain, tile, enamel, and glass; as molding sand for use in foundries; as abrasives in cleansing and scouring compounds; and as fillers. Average prices in 1940 are given on page 7.

SAND AND GRAVEL

The rocks containing quartz weather and break down, and the freed quartz masses grind upon each other until they are reduced to unconsolidated granular material. Most sands and gravels consist largely of quartz grains and pebbles, although impurities are usually present. For many purposes minor impurities are not harmful; however, glass sand and molding sand must conform to rather rigid chemical specifications. A diameter of about one-quarter inch is considered the dividing line between sand and gravel.

The sands that are by far the most important in tonnage and total value are the structural sands, which may be divided into two large groups: (1) Building sands, used in engineering and architectural structures, mortar, and plaster; and (2) paving sands, used in all forms of road and pavement construction. Because of the low price of structural sands, producers of these products must seek local markets.

The other sands have been named for their special uses, for example, molding sand is employed in foundries for making molds; glass sand in the manufacture of glass; engine sand to prevent the driving wheels of engines or the wheels of streetcars from slipping; grinding and polishing sand for sand blasting, scouring stone, sawing stone, grinding glass, sandpaper, and other abrasive uses; fire or furnace sand to line furnace bottoms and walls, particularly in open-hearth steel furnaces; and filter sand to remove sediment and suspended matter from water. Almost invariably these sands are high in silica, consisting chiefly of quartz grains. In some of them, especially glass sands, freedom from such ingredients as iron oxide is important, the permissible iron content depending upon the character or color of the glass to be produced. Filter sand requires rather careful sizing, and in molding sands the bond, usually clay, is important. Usually these special sands are obtained from deposits of unconsolidated material or from the crushing of friable sandstone.

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The use of gravel is virtually limited to local construction work and road building. Although some gravels are composed of free silica, many are made of silicate rocks.

A current trade journal quotes glass sand at $1.25 to $5 a ton, f. o. b. producing plant; molding sand, 50 cents to $3.50; and blast sand, $1.75 to $6. Average prices paid for the various sands and gravels in 1940 are given on page 8.

FLINT

Flint is a massive, tough silica that usually occurs as pebbles and boulders in chalk or marly limestones. It is opaque, light to dark gray, smoky brown, or brownish black, and frequently the nodules have a white coating.

Flint pebbles and tube-mill liners are utilized by grinders of certain ceramic materials in place of steel balls and liners because steel abraded from the grinding medium may contaminate the finished product. The feldspar industry is one of the largest users of flint grinding mediums. They are employed also by grinders of talc, soapstone, sandstone, quartz, chalk, sand and paint materials. Flint stones not suitable for use as grinding pebbles are crushed and ground for use in the manufacture of ceramics and for use as abrasives.

CHERT OR HORNSTONE

Chert or hornstone is a compact, massive rock similar in most properties to flint but less pure and usually light in color. It is employed mainly for roadstone but has been quarried and fashioned into millstones.

NOVACULITE

Novaculite is a fine-grained, compact rock quarried principally in the vicinity of Hot Springs, Ark. There are two varieties. The Arkansas stone is white and very dense, and has a waxy luster. The Washita (Ouachita) stone, much of which has a yellowish or rusty-red tint, is less dense and more porous than the Arkansas stone.

Novaculite is made into thin disks used for sharpening fine-edged instruments and small tools or ground into a powder for polishing and grinding watches and razor blades. It is also employed in making oilstones and whetstones.

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TRIPOLI AND ROTTENSTONE

Tripoli is a finely granular, porous, comparatively soft silica. It is the earthy, siliceous product of weathering limestone or calcareous chert and ranges in color from white to deep hematite red. The bulk of the Missouri-Oklahoma product is cream to pink. Most varieties of tripoli, except the hardest Illinois rock, can be scratched by the fingernail, and small fragments can be reduced to powder by rubbing them between the fingers. It is found in loosely coherent to fairly compact masses. The individual grains are very hard, although the massive material is generally soft.

Tripoli is used as an abrasive in scouring soaps and powders, washing powders for fabrics, metal polishes, and various metal-buffing compositions. Another important outlet for tripoli is in fillers, chiefly in paint. Tripoli is employed also in concrete admixture, foundry facing, oil-well drilling mud, filter block, glassmaking, ceramics, furnace insulation, and acoustic plasters.

Rottenstone, a fine-grained, gray-buff, siliceous, argillaceous limestone from Pennsylvania, is used as a base for polishes such as automobile polishes.

Tripoli and rottenstone are known to the trade as "soft silicas." The price received has been as low as $3 a ton at the mine. The selected grades of crude material sell for as much as $8 a ton on the car. The prices received for finished products fluctuate slowly. A recent trade-journal quotation for tripoli is as follows: "Per ton, burlap bags, paper liners, minimum carload 30 tons, f. o. b. Missouri: Once-ground through 40-mesh, rose and cream colored, $14.50; double-ground through 110-mesh, rose and cream, $16.00; air-floated through 200-mesh, $26."

DIATOMITE

Diatomite, an amorphous silica, comprises the siliceous skeletons of microscopic aquatic plants known as diatoms, of which some 8,000 species are known. Diatomite occurs either compact or loose as a fine-grained, white or gray earth, resembling chalk but with a gritty feel and hard enough to scratch glass. Diatomite is also known as diatomaceous earth, fossil flour, infusorial earth, and kieselguhr.

Diatomite is utilized for heat insulation; sound deadening in buildings; filtration, especially in sugar refining; fillers in products such as paint, paper, plastic rubber, battery boxes, and dynamite; admixtures for concrete, mortars, and cements; as a source of silica in the manufacture of glazes,

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enamels, sodium silicate or water glass, ultramarine, and sundry chemical products; as a mild abrasive in many metal polishes, powders, and pastes, automobile polishes, dental powders and pastes, and soaps; and occasionally as a friction agent in match heads or in the striking strips on the sides of match boxes. The quantity used for abrasives is insignificant compared to that used for other purposes. Most diatomite is consumed in pulverized form, although some is sawed in blocks.

Crude diatomite at deposits in the western United States is worth less than $5 a ton and upward. Standard products, admixtures, insulation, and filtration grades range in price from $10 to $40 a ton at the mines. For highly purified or selected specialty grades, the prices are $100 a ton or higher. A recent trade-journal quotation reads as follows: "Diatomite: Per ton, f. o. b. Nevada, dried crude, in bulk, $7, and in bags, $12; 40-mesh, $18; 200-mesh, $22.50; low-temperature insulation, $19; high-temperature, $40."

MILLSTONES AND CHASER STONES

Horizontal, circular millstones used for grinding grain were originally made of buhrstone, a porous stone consisting almost wholly of silica; however, true buhrstone is not produced in the United States, and domestic millstones are made from any hard and suitable rock such as sandstone, granite, quartzite, or quartz conglomerate. At present millstones are used to some extent in grinding paint. In 1940 millstones were produced in Ulster County, N. Y., from "Esopus" stone; in Rowan County, N. C., from granite; and in Montgomery County, Va., from quartzite.

Chaser stones are large circular stones, run on edge, made of the same material as millstones, but they are larger than millstones and are used for the coarse grinding of feldspar and other minerals.

GRINDSTONES AND PULPSTONES

Although there are many deposits of sandstone, only a few are suitable for conversion into grindstones and pulpstones. No matter how good the physical properties of the stone, the deposit is useless for these products unless the beds are thick enough and the joints far enough apart so that large grindstones or pulpstones can be cut from the quarried block.

Grindstones used for grinding saws, files, machine knives, scythes, and shears are made from large pieces of sandstone. Today the demand is mainly for stones more than 5 feet in diameter. In 1940, as in other recent years, grindstones were quarried in Ohio and West Virginia. The use of

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artificial grinding wheels has caused a gradual decline in production of the natural stone. Small pieces of very fine grained sandstone are employed for making grindstones to sharpen cutlery and scissors.

Pulpstones used for grinding wood into fine fiber for paper pulp are made from large pieces of sandstone, preferably 6 to 7 feet in diameter. Pulpstones are quarried in Washington and West Virginia. Artificial stones made from aluminum oxide and silicon carbide also have been used as pulpstones in recent years.

OILSTONES, WHETSTONES, HONES, SCYTHESTONES, AND RUBBING STONES

Among the dimension abrasive stones produced is a group of sharpening and rubbing stones generally operated by hand, including oilstones, whetstones, hones, scythestones, and rubbing stones, of which some are used dry and some with oil or water on the surface to prevent glazing.

Oilstones for sharpening fine tools and cutlery are produced principally in the Hot Springs (Ark.) district from a stone known as novaculite. They are very fine gritstones and give the most satisfactory service when used with oil.

Whetstones, hones, scythestones, and rubbing stones, employed for sharpening and rubbing, are made from sandstone in Indiana, New Hampshire, and Ohio. Whetstones also are made from Arkansas novaculite.

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BUYERS

Buyers for a product can be found by considering its uses then consulting a local classified telephone directory or regular trade directories, such as Thomas' Register of American Manufacturers and MacRae's Blue Book, which are available in most public libraries and local chamber of commerce headquarters. For example, a producer of a high-grade sand suitable for glassmaking may find a buyer among the glass manufacturers in his vicinity, and a person having agates for sale may find buyers among the manufacturers of agate bearings or mortars and pestles.

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The following lists of buyers include firms and individuals that have indicated to the Bureau of Mines that they are potential buyers and additional firms taken at random from trade directories. The lists are limited owing to lack of space. No lists are given for structural sand and gravel used for building and road work as these commodities find local use. Crushed and broken sandstone employed for shore protection and road work also is confined generally to local projects.

Possible Buyers of Massive Quartz and Quartzite

California:

Braun Corporation, 2260 E. 15th St., Los Angeles.
Commercial Minerals Co., 310 Irwin, San Francisco.
Crystal Silica Co., 717 E. 61st St., Los Angeles.

Delaware:

E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington.

Illinois:

Amalgamated Roofing Co., 6320 S. Central Ave., Chicago.
Central Commercial Co., 332 S. Michigan Ave., Chicago.
Chicago Abrasive Corporation, 3561 S. Normal St., Chicago.
A. Daigger & Co., 161 W. Kinzie St., Chicago.
Filter Paper Co., Filter Media Division, 61 E. 24th St., Chicago.
Garden City Sand & Fuel Co., 2408 S. Throop St., Chicago.
Geo. S. Mepham Corporation, East St. Louis.
F. E. Schundler & Co., Inc., 606 Railroad St., Joliet.
Tamms Silica Co., 228 N. La Salle St., Chicago.
Wedron Silica Co., 32-40 S. Dearborn St., Chicago.
Wehenn Abrasive Co., 811 W. Jackson Blvd., Chicago.

Iowa:

Keokuk Electro-Metals Co., Keokuk.

Maryland:

Davison Chemical Corporation, 20 Hopkins Pl., Baltimore.
Harford Talc & Quartz Co., Towson.

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Massachusetts:

American Abrasive Co., 100 Union Ave., Westfield.
Norton Co., New Bond St., Worcester.
H. A. Stiles & Co., 166-174 Portland St., Boston.
Waltham Grinding Wheel Co., Waltham.

Michigan:

Hygeia Filter Co., Denton and Klinger Sts., Detroit.

Minnesota:

Minnesota Mining & Mfg. Co., Halpin and Camp Sts., St. Paul.

Missouri:

Pioneer Silica Products Co., Pacific.

New Jersey:

J. T. Baker Chemical Co., North Phillipsburg.
H. C. Bugbird Co., Inc., 77 River St., Hoboken.
Calco Chemical Co., Inc., Bound Brook.

New York:

Behr-Manning Corporation, 1933 Sidford St., Troy.
Carborundum Co., Francis and Bowman Sts., Niagara Falls.
Cheesman-Elliott Co., Inc., Keep St. and Kent Ave., Brooklyn.
Corning Glass Works, Corning.
S. A. Day Mfg. Co., 1487 Niagara St., Buffalo.
Electro Refractories & Alloys Corporation, 6620 Andrews Bldg., Buffalo.
Eraser Co., Inc., 936 University Block, Syracuse.
Exolon Co., Commercial Ave. and Erie R. R., Blasdell.
General Electric Co., 1 River Rd., Schenectady.
McLeod & Henry Co., Inc., 39 Monroe St., Troy.
National Mfg. Corporation, Tonawanda.

New York City:

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza.
B. T. Babbitt, Inc., 386 Fourth Ave.
Charles B. Chrystal Co., Inc., 13 Park Pl.
Charles Cooper & Co., 4 Mulberry St.

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New York (Cont'd)

New York City Cont'd)

Dana & Co., 50 Church St.
Stanley Doggett, Inc., 473 Canal St.
Eimer & Amend, 201-209 E. 18th St.
Electro Metallurgical Co., 30 E. 42d St.
Federated Metals Division, 120 Broadway.
John W. Higman Co., 24 State St.
Innis, Speiden & Co., 121 Liberty St.
A. D. Mackay, 198 Broadway.
Johns-Manville Corporation, 22 E. 40th St.
Minerals & Insulation Corporation, 141 Spring St.
L. A. Salomon & Bro., 216 Pearl St.
Wm H. Scheel, Inc., Water and John Sts.
J. Lee Smith & Co., Inc., 23 Jacob St.
Speiden-Whitfield Co., Inc., 150 Nassau St.
C. Tennant Sons & Co. of New York, 9 Rockefeller Plaza.
United Feldspar Corporation, 10 E. 40th St.
Vanadium Corporation of America, 420 Lexington Ave.
Varlacoid Chemical Co., 116 Broad St.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway.
Wishnick-Tumpeer, Inc., 295 Madison Ave.

North Carolina:

Carolina China Clay Co., Penland.
Charlotte Chemical Laboratories, Inc., Gilchrist Bldg., Charlotte.
Penland Feldspar & Kaolin Co., Penland.

Ohio:

Philip Carey Co., 1935 Easton Blvd., (Lockland) Cincinnati.
Du Bois Soap Co., 1120 W. Front St., Cincinnati.
Harshaw Chemical Co., 1933 E. 97th St., Cleveland.
Industrial Silica Corporation, 1938 Coxy, Youngstown.
National Sales Corporation, 31 E. 13th St., Cincinnati.
National Smelting Works, 6700 Grant Ave., Cleveland.
North American Refractories Co., 613 Euclid Ave., Cleveland.
Ohio Ferro-Alloy Corporation, Canton.
Quality Products Co., 12435 Euclid Ave., Cleveland.

Oregon:

Miller Products Co., Portland.

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Pennsylvania:

Foote Mineral Co., Inc., 1609 Summer St., Philadelphia.
General Refractories Co., Broad and Chestnut Sts., Philadelphia.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh.
Haws Refractories Co., Johnstown, Pa.
O. Hommel Co., 211 Fourth Ave., Pittsburgh.
Osceola Silica & Fire Brick Co., Osceola Mills.
Pennsylvania Pulverizing Co., Lewistown.
Pittsburgh Metallurgical Co., Inc., 1738 Oliver Bldg., Pittsburgh.
Frank Samuel & Co., Inc., 2 S. 15th St., Philadelphia.
Westinghouse Electric & Mfg. Co., Hill St., E. Pittsburgh.

Rhode Island:

T. J. Quinn & Son, Inc., Ashton.

Tennessee:

Southern Ferro Alloys Co., Chattanooga.

Possible Buyers of Ground Quartz, Quartzite, Sandstone, Sand, or Flint for Ceramics Use

California:

Gladding, McBean & Co., 9th and Harrison Sts., San Francisco.

Colorado:

Coors Porcelain Co., Golden.

Illinois:

Albert Pick Co., Inc., 2159 W. Pershing Rd., Chicago.

Maryland:

Locke Insulator Corporation, P. O. Box 57, Baltimore.

Massachusetts:

Dedham Pottery Co., East Dedham.

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Missouri:

Missouri Pottery & Supply Co., Hoffmeister Ave. and Missouri Pacific R. R., St. Louis.

New Jersey:

Cook Ceramic Mfg. Co., 500 Prospect St., Trenton.
Fords Porcelain Works, Perth Amboy.
Frenchtown Porcelain Co., Muirhead and Dewey Aves., Trenton.
Imperial Porcelain Works, Inc., New York Ave. and Mulberry St., Trenton.
Scammell China Co., Trenton.
Star Porcelain Co., Muirhead and Dewey Aves., Trenton.
Trenton Potteries Co., Trenton.

New York:

Geo. Borgfeldt Corporation, 46 E. 23d St., New York.
Buffalo Pottery, Seneca St. and Hayes Pl., Buffalo.
Charles B. Chrystal Co., Inc., 13 Park Pl., New York.
General Ceramics Co., 30 Rockefeller Plaza, New York.
Iroquois China Co., Syracuse.
Lapp Insulator Co., Inc., Gilbert and Mills Sts., Le Roy.
Minerals & Insulation Corporation, 141 Spring St., New York.
Onondaga Pottery Co., Syracuse.
Robinson Clay Product Co., Empire State Building, New York.
L. A. Salomon & Bro., 216 Pearl St., New York.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York.
Wishnick-Tumpeer, Inc., 295 Madison Ave., New York.

Ohio:

Crooksville China Co., Crooksville.
Hall China Co., East Liverpool.
Harker Pottery Co., East Liverpool.
A. E. Hull Pottery Co., Crooksville.
Edwin M. Knowles China Co., East Liverpool.
Limoges-Sebring Associates, Sebring.
Salem China Co., 150 Railroad St., Salem.
Sebring Pottery Co., Sebring.
Specialty Porcelain Works, East Liverpool.
Steubenville Pottery Co., Steubenville.
Universal Potteries, Inc., Cambridge.
West End Pottery Co., East Liverpool.

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Oklahoma:

Frankoma Potteries, Inc., Sapulpa.

Pennsylvania:

Mayer China Co., Beaver Falls.
Shenango Pottery Co., New Castle.

Tennessee:

Nashville Pottery Co., Nashville.
Southern Potteries, Inc., Erwin.

West Virginia:

Jeffery Dewitt Insulator Co., Kenova.
Homer Laughlin China Co., Newell.
D. E. McNicol Pottery Co. of West Virginia, Clarksburg.
Porcelain Products, Inc., P. O. Box 830, Parkersburg.
Warwick China Co., Wheeling.

Buyers of High-grade Quartz Crystals (Radio and Optical Grade)

Maryland:

Bendix Radio Corporation, 920 E. 4th Ave., Baltimore.

Massachusetts:

American Optical Co., Southbridge.
Consolidated Electric Lamp Co., 600 Bond St., Lynn.
F. W. Sickles, Chicopee Falls.
Valpey Crystals, Box 321, Holliston.

New Jersey:

A. E. Miller, North Bergen.
Radio Corporation of America, Camden.
Western Electric Co., Kearney.

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New York:

Air Associates, Inc., Garden City, Long Island.
American Gem & Pearl Co., 6 W. 48th St., New York.
Bausch & Lomb, Rochester.
Brazilian Trading Co., 377 Fourth Ave., New York.
Diamond Drill Carbon Co., 63 Park Row, New York.
Electrical Research Products Corporation, 195 Broadway, New York.
General Electric Co., 1 River Rd., Schenectady.
International Telephone & Telegraph Corporation, 67 Broad St., New York.
Donald M. Murray Co., Inc., 38 Pearl St., New York.
Pan-American Trading Co., 67 Broad St., New York.
Premier Crystal Laboratories, 63 Park Row, New York.
Southern Cross Trading Co., 68 W. 58th St., New York.

Pennsylvania:

Bliley Electrical Co., Erie.
Foote Mineral Co., 1609 Summer St., Philadelphia.
Standard Piezo Co., Carlisle.

Texas:

Eidson's, 1309 N. Second St., Temple.

Possible Buyers of Quartz Crystals for Fusing

New Jersey:

Amersil Co., Inc., Trautmann Ave., Hillside.
Hanovia Chemical & Mfg. Co., 92 Chestnut St., Newark.

New York:

Eimer & Amend, 201-209 E. 18th St., New York.
General Electric Co., 1 River Rd., Schenectady.
International Selling Corporation, 26-28 Beaver St., New York.
Premier Crystal Laboratories, Inc., 63 Park Row, New York.
Thermal Syndicate, Ltd., 12 E. 46th St., New York.

Pennsylvania:

Foote Mineral Co., Inc., 1609 Summer St., Philadelphia.

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Possible Buyers of Quartz for Pulverizing and Use in Abrasives

Illinois:

Wedron Silica Co., 32-40 S. Dearborn St., Chicago.
Wehenn Abrasive Co., 811 W. Jackson Blvd., Chicago.

Massachusetts:

Abrasive Products, Inc., 100 Pearl St., South Braintree.
Harrison & Co., 490 Groveland St., Haverhill.
Norton Co., New Bond St., Worcester.

New York:

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York.
Charles B. Chrystal Co., Inc., 13 Park Pl., New York.
Minerals & Insulation Corporation, 141 Spring St., New York.
New England Quartz Co. of New York, 450 Seventh Ave., New York.
New Jersey Pulverizing Co., 205 W. 34th St., New York.

Pennsylvania:

Geo. F. Pettinos, Inc., 1200 Locust St., Philadelphia.

Wisconsin:

Disc Grinding Compound Co., Inc., W. Pierce and 36th Sts., Milwaukee.

Buyers of Gem Stones

California:

California Jewelry Co., 704 Market St., San Francisco.

Maine:

Maine Mineral Store, West Paris.

Massachusetts:

Jensen Jewel Co., Waltham.

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Montana:

Larimers Agate Shop, Glendive.

New York:

New York City:

Abel Bros. & Co., Inc., 16 Maiden Lane.
American Gem & Pearl Co., 6 W. 48th St.
Belgard & Frank, Inc., 31 W. 47th St.
Breidenbach Sons, Inc., 48 W. 48th St.
M. H. Shiman & Co., 48 W. 48th St.
Lucien M. Zell, 522 Fifth Ave.

Rhode Island:

John F. Allen & Son, 509 Westminster St., Providence.
Adolf Meller, 40 Fountain St., Providence.

Buyers of Agates for Industrial Use

Illinois:

Central Scientific Co., 1702 Irving Park Blvd., Chicago.
Glogau & Co., 1292 Rand McNally Bldg., Chicago.

New Jersey:

Bracher Agate & Abrasive Co., 482 Morris Ave., Summit.
Moser Jewel Co., Perth Amboy.

New York:

F. Baumgardt, 198 Broadway, New York.
W. & L. E. Gurley, Troy.

Possible Buyers of Sandstone for Cutting into Building Stone, Paving Block, Curbing, or Flagging

California:

Raymond McGilvray Corporation, 3 Potrero Ave., San Francisco.

Michigan:

Inland Lime & Stone Co., Manistique.

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New York:

Jerome A. Jackson, Long Island City.
Tompkins-Kiel Marble Co., Long Island City.

Ohio:

Cleveland Quarries Co., Builders Exchange Bldg., Cleveland.
Nicholl Stone Co., Lorain.
Ohio Cut Stone Co., Builders Exchange Bldg., Cleveland.

Possible Buyers of Crushed or Broken Sandstone

California:

Crystal Silica Co., 717 E. 61st St., Los Angeles.
Emsco Refractories Co., 5601 S. Boyle Ave., Los Angeles.

Illinois:

Amalgamated Roofing Co., 6620 S. Central Ave., Chicago.
Wedron Silica Co., 32-40 S. Dearborn St., Chicago.
Wehenn Abrasive Co., 811 W. Jackson Blvd., Chicago.

Massachusetts:

Norton Co., New Bond St., Worcester.

New York:

Electro Refractories & Alloys Corporation, 6620 Andrews Bldg., Buffalo.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York.
Wishnick-Tumpeer, Inc., 295 Madison Ave., New York.

Ohio:

National Sales Corporation, 31 E. 13th St., Cincinnati.
North American Refractories Co., 613 Euclid Ave., Cleveland.

Pennsylvania:

General Refractories Co., Broad & Chestnut Sts., Philadelphia.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh.

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Possible Buyers of Ground Sand and Sandstone and Special Silica Sands - Engine, Filtering, Foundry Molding, Glass, etc.

California:

Crystalite Products Co., Glendale (glass).
Crystal Silica Co., 717 E. 61st St., Los Angeles.
Tyre Bros. Glass & Paint Co., 31st and San Pedro Sts., Los Angeles (glass).

Illinois.

Tamms Silica Co., 228 N. La Salle St., Chicago.
Wedron Silica Co., 32-40 S. Dearborn St., Chicago.
Wehenn Abrasive Co., 811 W. Jackson Blvd., Chicago.

Michigan:

Ford Motor Co., Dearborn (glass).

Missouri:

Pearson-Ferguson Chemical Co., Kansas City.

New York:

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York.
Semon Bache & Co., 640 Greenwich St., New York (glass).
Carborundum Co., Francis and Bowman Sts., Niagara Falls.
Corning Glass Works, Corning (glass).
The Exolon Co., Commercial Ave. and Erie R. R., Blasdell.
Minerals & Insulation Corporation, 141 Spring St., New York.
New England Quartz Co. of New York, 450 Seventh Ave., New York.

Ohio:

The Harshaw Chemical Co., 1933 E. 97th St., Cleveland.
Hill & Griffith, 1265 State Ave., Cincinnati.
Industrial Silica Corporation, 1938 Coxy, Youngstown.
Libbey-Owens-Ford Glass Co., 1232 Nicholas Bldg., Toledo (glass).

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Pennsylvania:

Franklin Glass Corporation, Butler (glass).
O. Hommel Co., 211 Fourth Ave., Pittsburgh.
Pennsylvania Pulverizing Co., Lewistown.
George F. Pettinos, Inc., 1200 Locust St., Philadelphia.
Pittsburgh Plate Glass Co., 2222 Grant Bldg., Pittsburgh (glass).
Pittsburgh Silica Sand Co., Clark Bldg., Pittsburgh.
Safetee Glass Co., Stenton Ave. & Louden St., Philadelphia (glass).
Silicon Products Co., Ridgway.

Buyers of Flint Pebbles

Delaware:

E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington.

Indiana:

National Tile Co., Inc., Anderson.

Iowa:

Jasper Stone Co., Sioux City.

New Jersey:

Paul O. Abbe, Inc., 139 Center Ave., Little Falls.
Eureka Flint & Spar Co., Trenton.

New York:

New York City:

Abbe Engineering Co., 54 Church St.
J. R. Alsing Engineering Co., 50 Church St.
Buebendorf Bros., 2 Broadway.
John W. Higman Co., 24 State St.
New Jersey Pulverizing Co., 205 W. 34th St.
F. L. Smidth & Co., 225 Broadway.

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Ohio:

Crooksville China Co., Crooksville.
National Sales Corporation, 31 E. 13th St., Cincinnati.
Ohio Brass Co., Mansfield.
Patterson Foundry & Machine Co., East Liverpool.
West End Pottery Co., East Liverpool.

Pennsylvania:

Charles A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.

West Virginia:

Bowers Pottery Co., Mannington.
Carr China Co., Grafton.

Wisconsin:

Manitowoc Engineering Works, Manitowoc.

Possible Buyers of Tripoli and Rottenstone

California:

Braun Corporation, 2260 E. 15th St., Los Angeles.

Illinois:

Allied Industrial Products Co., 19 N. Elizabeth St., Chicago.
Charles F. L'Hommedieu & Sons Co., 4525 Ogden Ave., Chicago.
Matchless Metal Polish Co., 842 W. 49th Pl., Chicago.
George S. Mepham Corporation, East St. Louis.
James H. Rhodes & Co., 153 W. Hubbard St., Chicago.
Tamms Silica Co., 228 N. La Salle St., Chicago.

Michigan:

Krigner Tripoli Co., 426-428 Campbell Ave. S., Detroit.
J. C. Miller Co., Lake Michigan Drive & New York Central R. R., Grand Rapids.
Frederic B. Stevens, Inc., 500-520 Third St., Detroit.

Missouri:

Barnsdall Tripoli Corporation, Seneca.

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New Jersey:

Hanson-Van Winkle-Munning Co., East Matawan.
Munning & Munning, Inc., 204 Emmett, Newark.

New York:

Barker Bros., Inc., 2022 Pacific St., Brooklyn.
S. A. Day Mfg. Co., 1487 Niagara St., Buffalo.
Larkin Co., Inc., 680 Seneca St., Buffalo.

New York City:

Charles B. Chrystal Co., Inc., 13 Park Pl.
Stanley Doggett, Inc., 473 Canal St.
Eimer & Amend, 201-209 E. 18th St.
King & Malcolm Co., Inc., 242 Water St.
Minerals & Insulation Corporation, 141 Spring St.
L. A. Salomon & Bro., 216 Pearl St.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway.

Ohio:

Du Bois Soap Co., 1120 W. Front St., Cincinnati.
Harshaw Chemical Co., 1933 E. 97th St., Cleveland.
National Sales Corporation, 31 E. 13th St., Cincinnati.

Pennsylvania:

Samuel H. French Paint Co., 400-412 Callowhill St., Philadelphia.
Walter C. Gold, 235 Race St., Philadelphia.
Penn Paint & Filler Co., Antes Fort.
Chas. A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.
Westinghouse Electric & Mfg. Co., 35 Cable Ave., E. Pittsburgh.

Buyers of Diatomite

California:

Braun Corporation, 2260 E. 15th St., Los Angeles.
Marshall Dill, 30 Bluxome St., San Francisco.
Industrial Minerals & Chemical Co., Berkeley.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles.

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Colorado:

Gates Rubber Co., 999 S. Broadway, Denver.

Connecticut:

Jenkins Bros. Rubber Division, 510 Main St., Bridgeport.

Illinois:

Abbott Laboratories, North Chicago.
A. Daigger & Co., 161 W. Kinzie St., Chicago.
Filter Paper Co., Filter Media Division, 61 E. 24th St., Chicago.
F. E. Schundler & Co., Inc., 606 Railroad St., Joliet.
Tamms Silica Co., 228 N. La Salle St., Chicago.

Massachusetts:

H. A. Stiles & Co., 166-174 Portland St., Boston.

Michigan:

Hygeia Filter Co., Denton & Klinger Sts., Detroit.

Missouri:

Standard Asbestos Mfg. & Insulating Co., 10 N. Olive St., Kansas City.

New Jersey:

H. C. Bugbird Co., Inc., 77 River St., Hoboken.
Joseph Stokes Rubber Co., 220 Webster St., Trenton.

New York:

Larkin Co., Inc., 680 Seneca St., Buffalo.
Smith Chemical & Color Co., Inc., 55 John St., Brooklyn.

New York City:

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza.
American Hard Rubber Co., 9 Mercer St.
Charles B. Chrystal Co., Inc., 13 Park Pl.
Stanley Doggett, Inc., 473 Canal St.

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New York (Cont'd)

New York City (Cont'd)

Eimer & Amend, 201-209 E. 18th St.
Electro-Metallurgical Co., 30 E. 42d St.
Hammill & Gillespie, Inc., 240 Front St.
Industrial Chemical Sales Division, 1333 New York Central Bldg.
Innis, Speiden & Co., 121 Liberty St.
Johns-Manville Corporation, 22 E. 40th St.
Minerals & Insulation Corporation, 141 Spring St.
Pomeroy & Fischer, Inc., 95 Madison Ave.
L. A. Salomon & Bro., 216 Pearl St.
Wm. H. Scheel, Water and John Sts.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway.
Wishnick-Tumpeer, Inc., 295 Madison Ave.

Ohio:

Coleman & Bell Co., Norwood.
Du Bois Soap Co., 1120 W. Front St., Cincinnati.
Globe Chemical Co., Inc., Murray Rd. and Big 4 R.R., Cincinnati.
B. F. Goodrich Co., 448 S. Main St., Akron.
Harshaw Chemical Co., 1933 E. 97th St., Cleveland.
National Sales Corporation, 31 E. 13th St., Cincinnati.
Richardson Co., 39 S. Cooper Ave., (Lockland) Cincinnati.

Oregon:

Miller Products Co., Portland.

Pennsylvania:

General Refractories Co., Broad and Chestnut Sts., Philadelphia.
Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh.
Chas. A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.

Possible Buyers of Sandstone or Quartzite for Manufacture of Millstones and Chaser Mills

New Jersey:

Paul O. Abbe, Inc., 139 Center Ave., Little Falls.

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New York:

Abbe Engineering Co., 54 Church St., New York.

Ohio:

Patterson Foundry & Machine Co., East Liverpool.

Pennsylvania:

Peter F. Campbell, 55 Laurel, Philadelphia.
Hardinge Co., Inc., York.

Possible Buyers of Sandstone for Manufacture of Whetstones, Hones, Scythestones, Grindstones, and Pulpstones

Illinois:

Goodrich Grinding Wheel Co., 1500 W. Madison St., Chicago (hones).
Prater Pulverizer Co., 1827-1837 S. 55th Ave., Chicago (pulpstones).
James T. Rhodes & Co., 153 W. Hubbard St., Chicago (hones, rubbing stones).
Richards-Wilcox Mfg. Co., 316 W. 3d St., Aurora (grindstones).

Massachusetts:

Norton Co., New Bond St., Worcester (hones, scythestones, pulpstones).
H. A. Stiles & Co., 166-174 Portland St., Boston (rubbing stones).

Missouri:

American Pulverizer & Crusher Co., 1249 Macklind Ave., St. Louis (pulpstones).

New Jersey:

Paul O. Abbe, Inc., 139 Center Ave., Little Falls (pulpstones).
Bracher Agate & Abrasive Co., 482 Morris Ave., Summit (hones, scythestones).
Pulverizing Machine Co., 119 Valley Rd., Roselle Park (pulpstones).
Tilco Abrasive Mfg. Co., 30 Sterling St., East Orange (scythestones, etc.).

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New York:

Ball & Jewell, 20 Franklin St., Brooklyn (pulpstones).
Behr-Manning Corporation, 1933 Sidford St., Troy (hones, whetstones, rubbing stones).
Carborundum Co., Francis and Bowman Sts., Niagara Falls (hones, whetstones, rubbing stones, pulpstones).

Ohio:

Cleveland Quarries Co., Builders Exchange Bldg., Cleveland (scythestones, grindstones).
Jeffrey Mfg. Co., 956-99 N. 4th St., Columbus (pulpstones).
Nicholl Stone Co., Lorain (whetstones, grindstones).

Possible Buyers of Novaculite for Manufacture of Oilstones and for Grinding and Use in Abrasives

Massachusetts:

Norton Co., New Bond St., Worcester.

New Jersey:

Bracher Agate & Abrasive Co., 482 Morris Ave., Summit.
Tilco Abrasive Mfg. Co., 30 Sterling St., East Orange.

New York:

Behr-Manning Corporation, 1933 Sidford St., Troy.
Carborundum Co., Francis and Bowman Sts., Niagara Falls.

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